

July 9, 2007

TO: D. Morris
FROM: A. Andujo
SUBJECT: DSS-46 and DSS-66 Closure Impact Study

Background

The Resource Analysis Team has completed a special study to analyze the ability of the DSN to provide support to the projected users of DSN antenna resources. In an effort to reduce cost throughout the DSN, JPL and Deep Space Mission Services will retire the 26 Meter antenna network. We have been tasked to analyze the impact of these closures to the users of the DSN. This study focuses on identifying a time when closing DSS-46 and DSS-66 would least impact mission supportability from September 29, 2008, during the DSS-43 and DSS-63 6-month downtimes. This is a follow up to previous studies done to analyze the impact of decommissioning the DSS-46 and DSS-66 antennas in 2005.

Summary of Results

The effect of decommissioning DSS-46 and DSS-66 during the period analyzed results in an increase to unsupportable time for some users across all subnets. Most missions are unaffected, but ACE, CLU2 and SOHO are most impacted. Although supportable time is not reduced as much for other missions the impact will be an increased difficulty negotiating support time. Canberra antennas see an increase to unsupportable time throughout this period due to offloading. Adding an S-Band uplink at DSS-45 helps to reduce offloading to DSS-34, but additional capacity is required at Canberra to support existing requirements. Decommissioning DSS-46 would leave only 3 antennas in Canberra and in the event of an antenna failure or downtime, as planned for DSS-43 in weeks 40 of 2008 – 13 of 2009, sharply decreases supportability at Canberra. The Cluster II mission's requirement for simultaneous acquisition with 3 - 4 antennas can not be fully satisfied especially in the event of a downtime. The addition of Acquisition Aid capability at the 34BWG1 places more load on the 34BWG1 subnet. The loss of DSS-46 would more severely impact Canberra on the whole as there would be too few antennas to support Southern hemisphere requirements. An important consideration when planning to decommission DSS-46 and DSS-66 is the Low Earth Orbiter emergency backup support mission set. The DSN may not be able to support these LEO missions without the 26 meter antennas. Decommissioning DSS-46 in this time period is not recommended.

The addition of an S-Band uplink at DSS-45 and DSS-65 helps DSS-34 and DSS-54 handle any offloading from DSS-46 and DSS-66. The Cluster Array requirement is also a concern at Madrid, as Cluster cannot be supported by DSS-55, leaving only DSS-63, 65 and 54 to support the mission Wide-band Data Collection activities. The NOAA-N' launch would require S-Band Acquisition Aid support from DSS-66 in 2008. The Low Earth Orbiter emergency backup support mission set should be considered when planning the DSS-66 decommissioning. Decommissioning DSS-66 in this time frame is not recommended.

Assumptions

Analysis was accomplished using the updated mission set database from the February 2007 Resource Allocation Review (RAR).

Supports displaced as a result of the DSS-46 and DSS-66 antenna decommissioning are mostly S-Band missions managed by SSMO and are mostly reallocated to a resource with S-Band capability such as the 34BWG1, 34HEF and 34HSB Subnets.

During analysis several factors were considered:

- DSS-16 closed 2005
- DSS-43 downtime Week 40/2008 – 13/2009
- DSS-63 downtime Week 14/2009 – 39/2009
- DSS-24 downtime Week 28/2009 – 38/2009
- DSS-27 upgraded with full TT&C (NSP, SLE)
- DSS-45 and 65 upgraded with S-Band Uplink capability
- DSS-46 closed as early as September 29, 2008
- DSS-66 closed as early as September 29, 2008

Current Key Mission Requirements

- The ACE, CLUSTER II, Geotail, and SOHO missions all utilize the 26 meter subnet in order to meet their mission requirements
- 40% of CLUSTER II's Wide-Band Data (WBD) Opportunities are in the Southern hemisphere and require simultaneous tracking support from three to four apertures
- SOHO HSO is planned for weeks 21 through 29 of 2009
- SOHO will be in their Keyhole period in:
 - Weeks 45 – 47 of 2008
 - Weeks 05 – 08 of 2009
 - Weeks 18 – 20 of 2009
 - Weeks 30 – 34 of 2009
 - Weeks 44 – 46 of 2009
- Kepler Mission is scheduled to launch on November 1, 2008, DSS-46 support required for launch and initial acquisition.

Current mission requirements dictate the specific use of DSS-46 and DSS-66, for both nominal activities and critical events. As a result of the 26 meter subnet closure some users have offloaded support to the 34 meter or 70 meter subnets, but not all missions have this option. In the case of DSS-46 offloading increases contention on the 34 and 70 meter subnets by a maximum of 6 percent.

Several Low Earth Polar and Equatorial Orbiting missions rely upon the DSN 26 meter subnet for emergency and backup support. These LEO missions are not capable of being supported at other DSN subnets due to the nature of their orbit.

Other major events and downtimes occurring during the study period are listed in the supporting data attached at the end of this study.

Analysis

The decrease of unsupportable time caused by the DSS-46 and DSS-66 decommissioning in this study is statistically minor. The key factors for maintaining the DSS-46 and DSS-66 antennas in operation in this period are as follows:

- DSS-43 downtime reduced supportable time at an already overloaded DSS-34 antenna
- Emergency Support for LEO missions is a committed requirement that the DSN must meet
- Science objectives of the Cluster II mission require support from 3 – 4 antennas simultaneously. Reducing the number of antennas that can support the mission at two complexes jeopardizes the DSN's ability of meeting the requirement.
- Although Acquisition Aid requirements may be met by implementing capability at 34BWG1 antennas this will further increase loading at this subnet

Individual Missions have experienced mixed results, but for the most part the DSS-46 and 66 increases unsupportable time for all missions by approximately 1.8%. The upgrade of the DSS-27 antenna and the S-Band Uplink addition of the 34 HEF antennas help make it possible for the DSN to absorb the offloading of these two 26 meter antennas.

Conclusion

Based on forecast data gathered from User Loading Profiles (ULP's) for all active missions, the DSN can provide approximately 83.1% all of the currently requested support; if DSS-46 and DSS-66 are decommissioned in September 30, 2008, supportability drops to an average of 84.9%, an overall change of less than two percent. This average does not reflect that some missions supportability, specifically ACE and SOHO drop as low as 46% in some periods. Supportability is reduced by an average of 38.6% for SOHO and 12.28% for ACE due to the DSS-46 and DSS-66 decommissioning.

Decommissioning DSS-46 would more severely impact Canberra on the whole as there would be too few antennas to support Southern hemisphere requirements and specific mission requirements. A mission requesting continuous coverage or multiple simultaneous antennas will cause increased unsupportable time for all other missions. Future Acquisition Aid will be supported by an already oversubscribed 34BWG1 subnet.

The addition of an S-Band uplink at the 34 meter HEF antennas does assist in offloading DSS-66 but would not be sufficient to support the decommissioning of DSS-46, as DSS-45 is already capacity within the daylight viewperiod. Overall the 34 HEF subnet is already at capacity, and supportability drops where SOHO keyhole and HSO requirements were moved from 26 Meter antennas. Additional loading during SOHO Keyhole periods to 34 Meter antennas is required to

provide the S-Band uplink while also assigning a 70 meter or 34 meter to provide high-rate downlink support would leave only 1 antenna in Canberra and 2 antennas in Madrid to provide all other missions support during the Sun View period will cause a marked increase to unsupportable hours at the complex selected.

Mars missions are primarily affected by this due to the viewperiod overlap between Mars and Sun in this period by an average of 64% in 2008, considering that Phoenix will launch in August 2007 and will arrive at Mars and begin orbital operations in May 2008 any high contention period at an entire complex will be detrimental to the support of all DSN missions. May through December 2008 produces an average Mars/Sun viewperiod overlap of 82%. SOHO HSO increased support requirements also produces a high level of contention in this period as well. The addition of an S-Band uplink to the DSS-45 and DSS-65 antennas will not reduce the impact of decommissioning all 26 meter antennas, yet would be necessary to provide an additional S-Band uplink capability, as Canberra and Madrid do not have a “DSS-27” type antenna available for backup.

Recommendations

- Based on this study case it is recommended that DSS-66 not be decommissioned earlier than the end of extended mission for Cluster II, which at this time is planned for September 30, 2010, as well as an expected extension to SOHO to October 1, 2011. With the condition that Acquisition Aid capability is implemented in Madrid to support.
- It is also recommended that DSS-46 not be decommissioned until the end of mission of most current SSMO missions, specifically the Cluster II mission in September 30, 2010. With the condition that Acquisition Aid capability is implemented in Canberra.
- It is also recommended that a 34 Meter BWG1 type antenna be built in Canberra
- As an alternative to completely shutting down these antennas, reduce operations to daylight hours only, when users are in view.

Supporting Data

Figure 1: DSN User Mission Set 2008 - 2014

Project	Acronym	Launch or Start	EOPM	EOEM	2008	2009	2010	2011	2012	2013	2014
Advanced Composition Explorer	ACE	08/25/97	02/01/01	10/01/13							
Advanced Tracking and Observational Techniques (ATOT)	ATOT	02/01/02	12/31/08	---							
Cassini	CAS	10/15/97	06/30/08	06/30/10							
Chandra X-Ray Observatory	CHDR	07/23/99	07/24/09	07/24/14							
Chandrayaan - 1	?	03/01/08	03/01/10	TBD							
Cluster 2 - S/C #1 (Salsa)	CLU1	08/09/00	02/15/03	09/30/10							
Cluster 2 - S/C #2 (Samba)	CLU2	07/16/00	02/15/03	09/30/10							
Cluster 2 - S/C #3 (Rumba)	CLU3	07/16/00	02/15/03	09/30/10							
Cluster 2 - S/C #4 (Tango)	CLU4	08/09/00	02/15/03	09/30/10							
Dawn	DAWN	06/30/07	07/04/15	TBD							
DSN Antenna Calibration	DSN	--	--	--							
DSN ZDD Calibration	DSN	11/01/04	--	--							
DSS Maintenance	DSS	--	--	--							
European and Global VLBI Systems	EGS	--	--	--							
Geotail	GTL	07/24/92	07/24/95	10/01/08							
Goldstone Solar System Radar	GSSR	04/01/85	--	--							
Ground Based Radio Astronomy	GBRA	--	--	--							
Hayabusa (MUSES - C)	MUSC	05/09/03	06/10/10	TBS							
International Gamma Ray Astrophysics Lab	INTG	10/17/02	12/18/04	12/16/10							
James Webb Space Telescope	JWST	06/01/13	07/31/16	TBD							
Juno	JUNO	08/11/11	08/11/17	TBD							
Kepler	KEPL	11/01/08	12/31/12	TBD							
Lunar Crater Observation and Sensing Satellite (LCROSS)	LCRO	10/31/08	01/31/09	TBD							
Lunar Reconnaissance Orbiter	LRO	10/31/08	09/31/10	TBD							
Mars Express Orbiter	MEX	06/02/03	02/11/06	12/31/08							
Mars Odyssey 2001	M01O	04/07/01	08/24/04	12/31/10							
Mars Orbiter 2013	M13O	11/28/13	08/21/16	TBD							
Mars Reconnaissance Orbiter	MRO	08/12/05	12/31/10	12/31/15							
Mars Science Laboratory 2009	MSL	09/15/09	03/04/12	TBD							
Mars Scout 2011 (TBS)	M11O	01/31/12	09/10/14	TBD							
Messenger	MSGR	08/03/04	03/19/12	---							
New Horizons	NHPC	01/19/06	04/17/16	TBD							
Opportunity (Mars Exploration Rover - B)	MER1	07/07/03	04/27/04	09/30/08							
Phoenix	PHX	08/03/07	10/26/08	TBD							
Reference Frame Calibration (Cat M&E and Clock Sync)	DSN	--	--	--							
Rosetta	ROSE	02/26/04	12/31/15	---							
SOHO	SOHO	12/02/95	05/02/98	10/01/11							
Space Geodesy	SGP	--	--	--							
Spirit (Mars Exploration Rover - A)	MER2	06/10/03	04/06/04	09/30/08							
Spitzer Space Telescope (SIRTF)	STF	08/25/03	05/31/09	05/31/14							
Stereo Ahead	STA	10/26/06	01/22/09	01/22/12							
Stereo Behind	STB	10/26/06	01/22/09	01/22/12							
Ulysses	ULYS	10/06/90	09/11/95	03/30/08							
Venus Express	VEX	11/09/05	09/24/07	01/22/09							
Voyager 1	VGR1	09/05/77	12/31/80	12/31/10							
Voyager 2	VGR2	08/20/77	10/15/89	12/31/10							
Wilkinson Microwave Anisotropy Probe	WMAP	06/30/01	10/01/03	09/30/10							
Wind	WIND	11/01/94	11/01/97	10/01/11							

Prime Mission = ■
 Extended Mission = ■
 26 Meter User Prime Mission = ■
 26 Meter User Extended Mission = ■

Figure 2: Impact to All Users Unsupportable Hours and Percentage

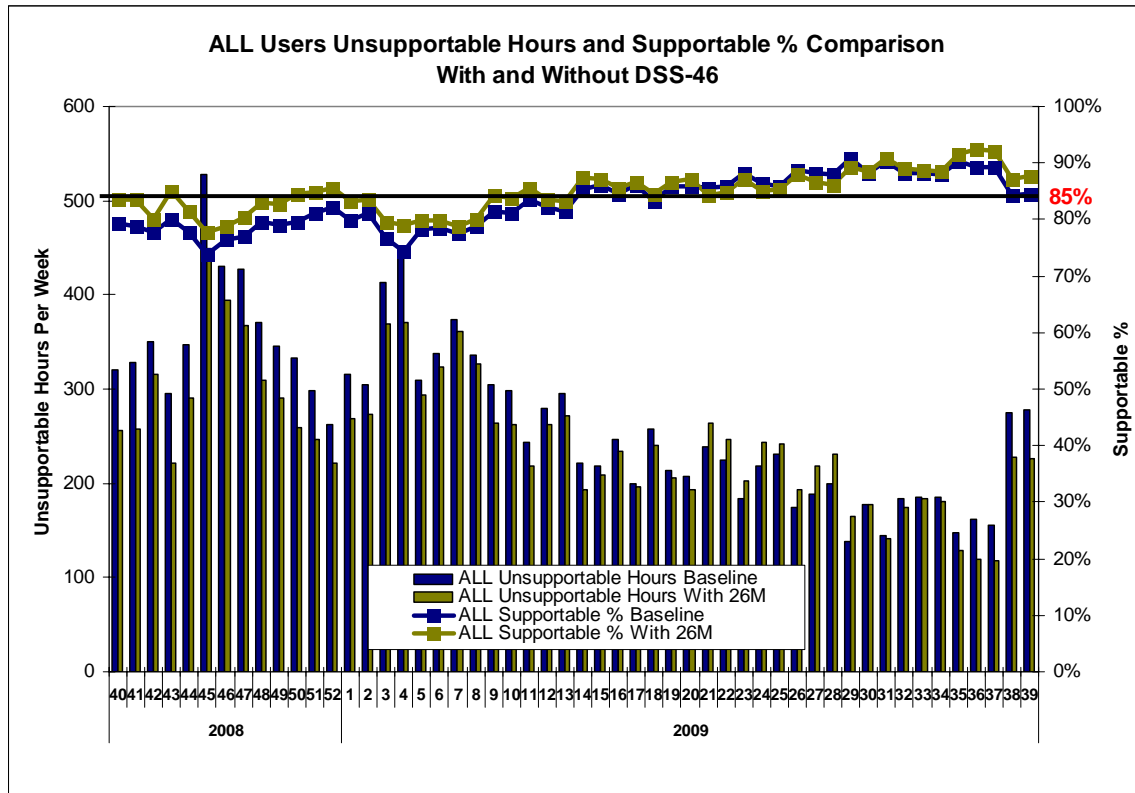


Figure 3: Impact to ACE Unsupportable Hours and Percentage

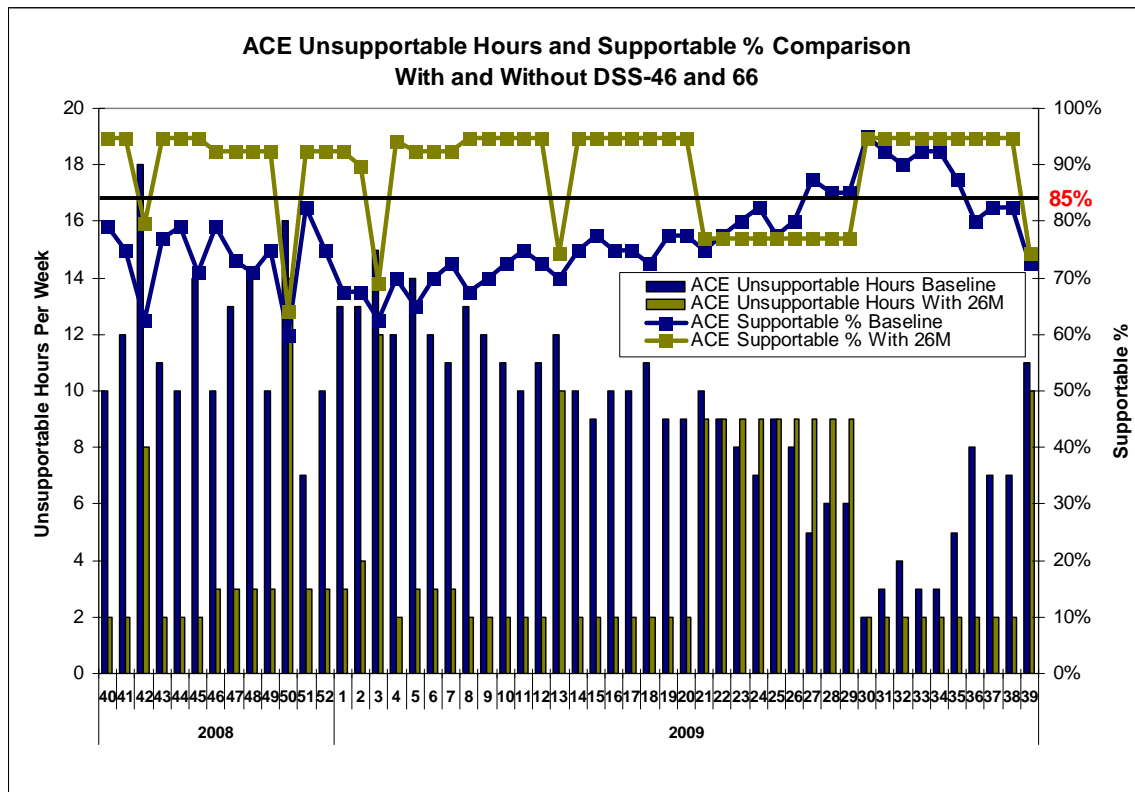


Figure 4: Impact to CLUS Unsupportable Hours and Percentage

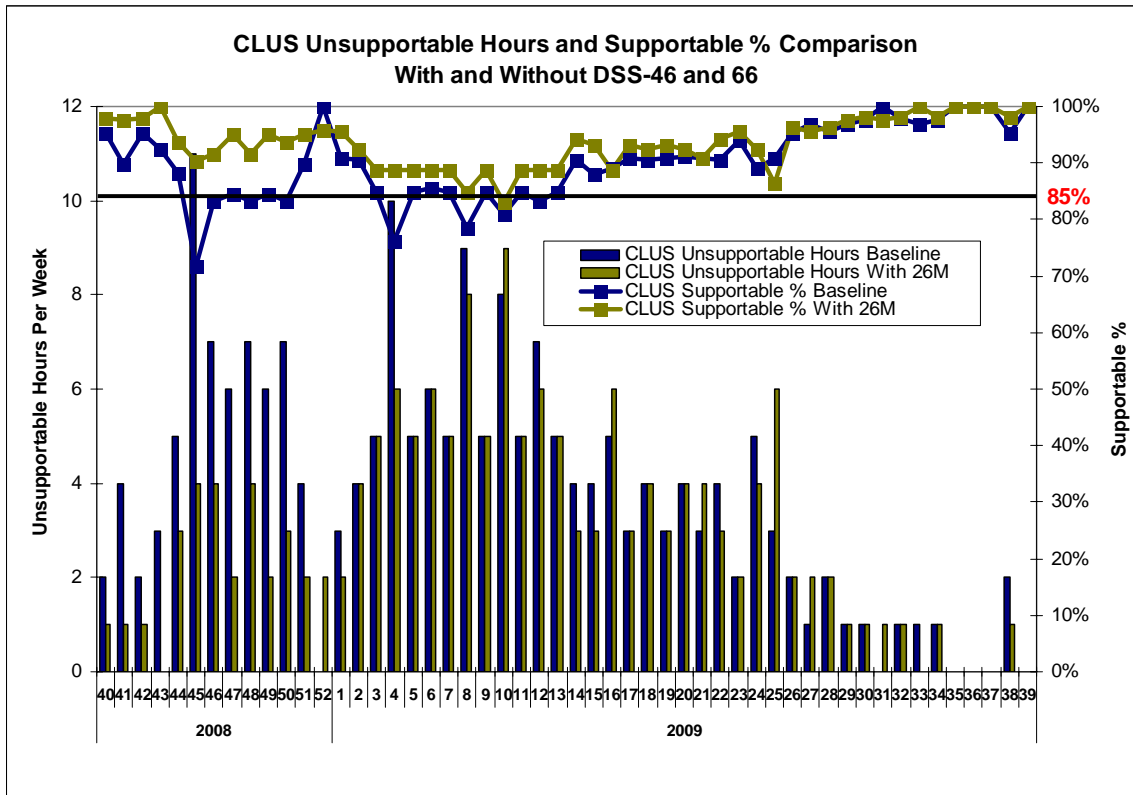


Figure 5: Impact to SOHO Unsupportable Hours and Percentage

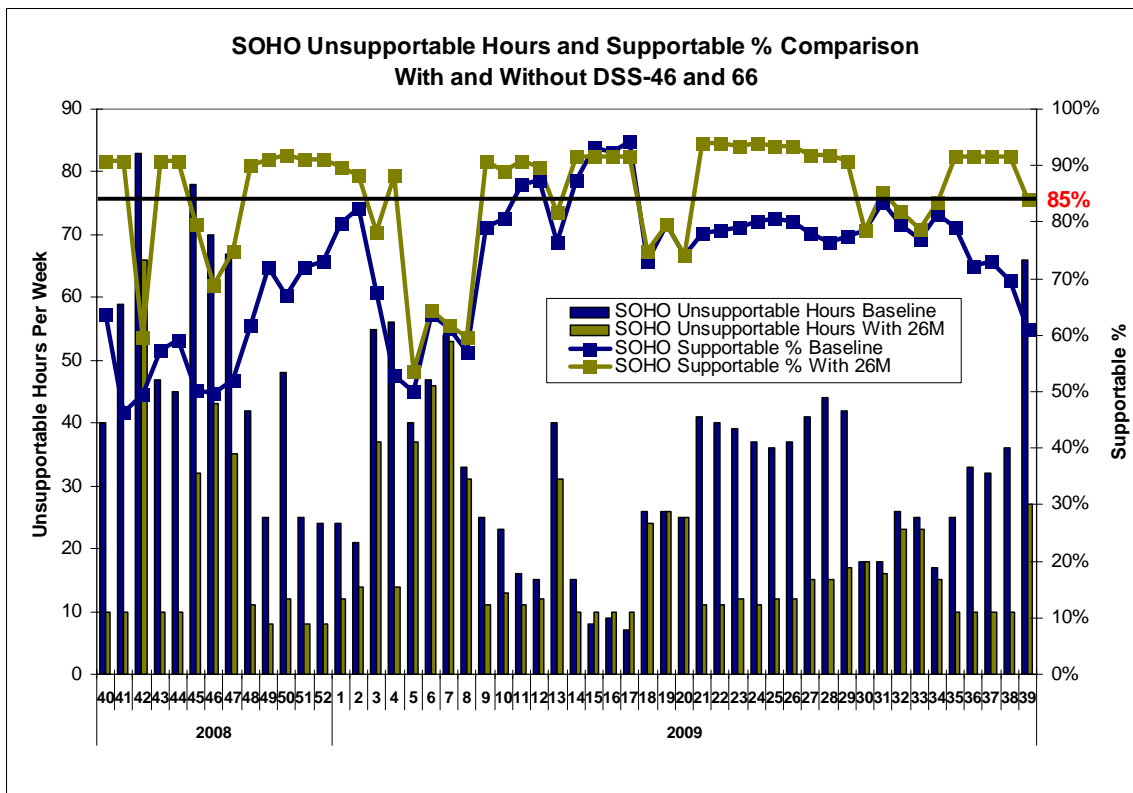
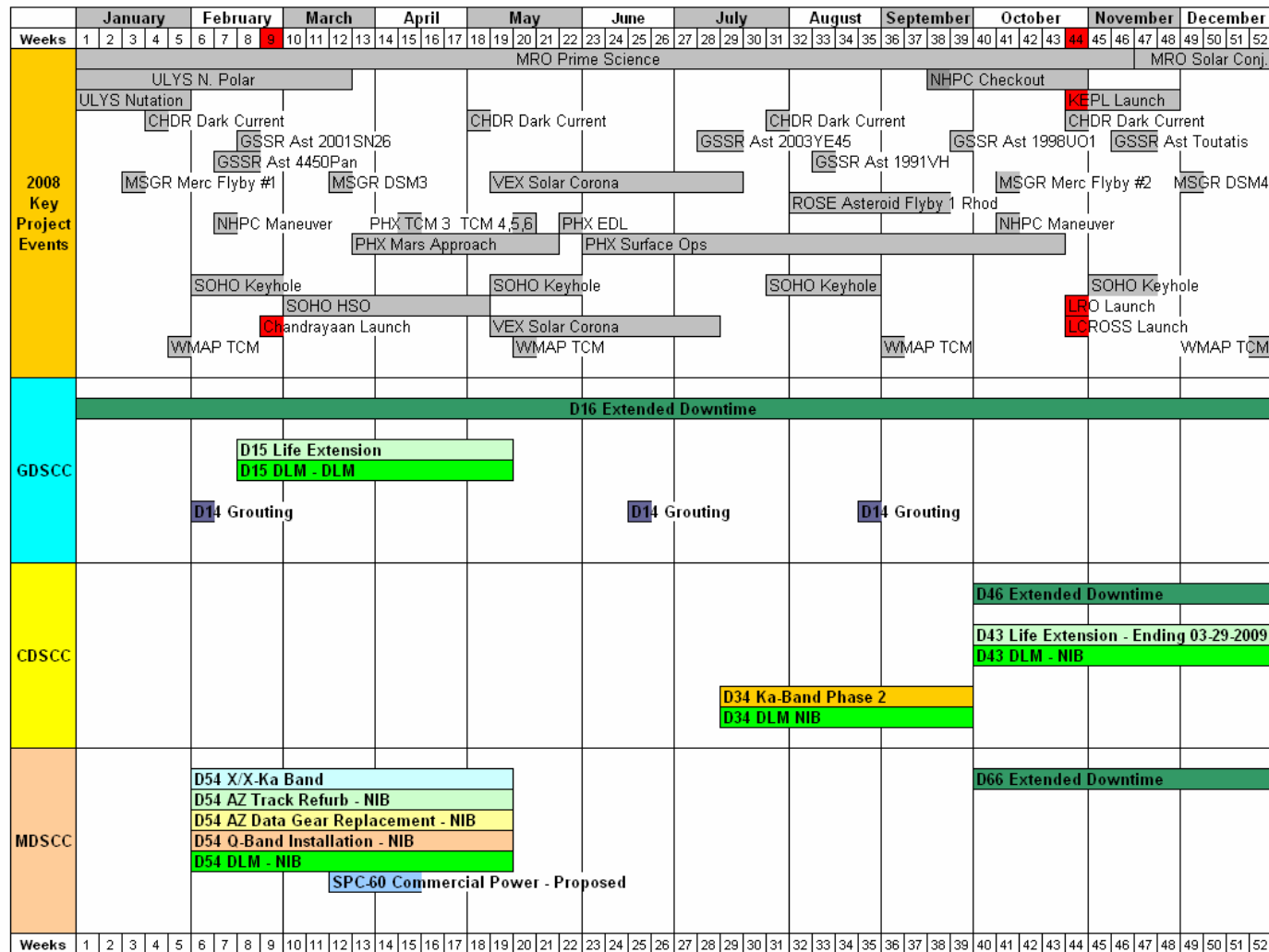


Figure 6: DSN Major Events and downtimes for 2008



Revised: March 12, 2007

Figure 7: DSN Major Events and downtimes for 2009

